# REGIONAL AND INTER-REGIONAL INPUT-OUTPUT MODEL AS A PLANNING TOOL FOR ECONOMIC DEVELOPMENT IN INDONESIA.

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# NAVAL POSTGRADUATE SCHOOL
## Monterey, California

# THESIS

REGIONAL AND INTER-REGIONAL
INPUT-OUTPUT MODEL AS A PLANNING TOOL
FOR ECONOMIC DEVELOPMENT IN INDONESIA

by

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This paper investigates the applicability of regional and inter-regional input-output models as a planning tool for guiding regional economic development. An inter-regional input-output model is developed which will, if implemented, allow regional economic planning to be accomplished in a consistent manner. It will permit a central planning office to coordinate the choices of the regional planning officials so that these will support national economic development.

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for Economic Development in Indonesia

by

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## ABSTRACT

Conspicuous inter-regional differences exist in population density and personal income in Indonesia. The future success of economic development in Indonesia requires the identification of some alternatives to the heavy concentration of the population on the island of Java.

This paper investigates the applicability of regional and inter-regional input-output models as a planning tool for guiding regional economic development. An inter-regional input-output model is developed which will, if implemented, allow regional economic planning to be accomplished in a consistent manner. It will permit a central planning office to coordinate the choices of the regional planning officials so that these will support national economic development.

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## I. INTRODUCTION

The use of an input-output model as a planning tool for economic development has received much attention in many countries. The administrative structure of government in Indonesia is highly centralized and the gaps of welfare among the regions are very large. The population problem, high rate of the population growth and the densities of the population over the regions are very distinctive. An economic model that can be applied is needed for Indonesia.

In this paper we suggest the input-output model. Part I of this paper is the historical, geographical, social and economic condition background. Also, the administrative structure has been touched in a very restricted measure. In Part II we describe the problem faced by government and the set of objectives that government attempts to obtain. Part II is the review of basic input-output theory as a basic method to the model suggested. Part IV is the regional and interregional input-output as the model. In this part is given the explanation, or computational method to solve the problem given in earlier parts. The last one is the closing where it is pointed out what we can get from the model as a planning tool and some recommendations for further expansion of the work.

## II. BACKGROUND

Indonesia consists of more than 12,000 large and small islands, and just about 8000 of them are populated. Among the South-East Asian countries Indonesia is the largest in area as well as in population. An interesting and somewhat startling fact is that Indonesia's horizontal sweep exceeds that of the United States, reaching all the way from California in the West to Bermuda in the East.

More than half of Indonesia's 119,383 million people live on the fertile island of Java, which has a population density averaging $565/km^2$, one of the highest densities in the world, whereas the population density of Indonesia is just $58/km^2$. Most of the remaining islands are underpopulated. Kalimantan as big as Texas, contains only slightly more than 4 million people and Sumatra is four times the size of Java which only has 19 million people. West Irian, Indonesia's half of New Guinea and still largely unexplored, has a population of just about 923,440 people — less than one million people and just about two persons per square kilometer.

The wealth of natural resources in Indonesia ranks third in the world.* Indonesia consists also of many tribes in population, in which each tribe is significantly different in culture, language and socio-economic condition. There

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*Howard Palfrey Jones, "Indonesia: The Possible Dream," Harcourt Brace Jovanovich, Inc., 1971.

are about 200 dialects in Indonesia, and the uniqueness is that Indonesian people have only one national language, which can be accepted by all tribes, that is Indonesian language or "Bahasa Indonesia."

During the Dutch occupation, being differences in the culture and split out by the sea of the Indonesian people had been used as the advantage for the "divide et empira" policy to survive the colonial administration in Indonesia, which was called East-Indie by the Dutch government. This is one of the reasons why the Indonesian people, after getting independence had chosen the highly centralized government to more fertilize the national feeling in unity as the first aim of the young government of the Republic of Indonesia. This can be seen clearly in the motto of the Republic of Indonesia:

"THE UNITY IN DIVERSITY"

As the result of this highly centralized government, Indonesia has suffered from an inability to reach the progress in economic development of the country, which leads the situation favorable for several rebellions or civil wars against the central government of unsatisfied groups of people, mostly people not living in Java, which reach the climax when the Communist Party of Indonesia tried to take over the government for the second time in 1965.

After 1965 the new government which was popular by that time as a "New Orde" had been inherited with the internal instability, the financial and economic crisis such as

running inflation, balance of payment crisis, accumulating foreign debt repayment obligation, etc.

Another obvious feature was the crisis of economic system itself; the economic system which had developed in the late fifties and the early sixties clearly had not been conducive to economic development and had even impeded it.

The new government evolved its policies for the stabilization and rehabilitation of Indonesia's economic system and creation of sound basis in economic growth. The main goal in economic growth was introduced to:

1. Increase in food production to meet self-supportive program in food, or less dependence on foreign imported food. The government is being aware in this program because international trade relationship is much dependent on the foreign policy of the countries with whom we have trade.

2. Increase in production of potentially exportable agricultural products, oil products and other mineral resources products in order to put the strong foundation or the basic intrustries for further development of the country.

Based on all the facts; that Indonesia consists of many different cultures; socio-economic conditions; islands, and on the other hand, the government is a highly centralized system, the use of an Input-Output model by the central government as a planning tool, for control and economic development of regions, to abolish or at least to decrease the great differences in income of the people among all regions until the certain levels, that can also help the

transmigration policy of the goverment to spread out the population from more density to less density regions as the manpower industry. The use of input-output models is a planning tool for economic development has received much attention in India, Korea, Italy* and other countries attributed to the economic measures derived from input-output analysis. The great advantage of input-output analysis is that it covers the wide range between extreme aggregation and complete disaggregation. Another major advantage of input-output analysis is its stress on interdependence; it is the only branch of economy which shows empirically how everything depends upon everything else. It has brought to realization in an operational form the grand design of general equilibrium theory had it roots in the work of Francois Quesnay and Leon Walras.

This paper represents an effort to model the regional economic development policy for the central government of Indonesia by using regional and interregional input output model.

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*Adelman, Irma, Practical Approaches to Development Planning: Korea's Second Five-Year Plan, The Johns Hopkins Press, Baltimore, 1969.

Hollis B. Chenery and Paul G. Clark, "Interindustry Economics, John Wiley and Sons, Inc., 1959.

## III. FIVE YEAR DEVELOPMENT PLAN

### A. NATURE AND OBJECTIVE OF FYDP

The Five Year Development Plan sets out development objectives and specifies policies, program and projects for the five year period beginning on April 1. It provides direction of the desired growth process and reflects the scale of priority ordering.

While the plan largely embraces development programs in the public sectors, the objectives and national priorities set forth in the plan are also designated for the private sector, since these objectives can only be achieved through coordinated actions of the two sectors.

The overriding goal of the FYDP is to rais the living standard of the whole people and to lay a strong foundation for the next stage of national development. It provides guidelines for the creation of expanding employment opportunities, a rising level of income, a more equitable distribution of income, a more even distribution of the gains of development among the various regions of the country, greater economic and social integration of the regions into one effective national entity, and enhanced quality of life, including environmental, cultural, nutritional aspects of life.

## B. PROGRAMS

The principal programs to be implemented within FYDP include those concerning:

- Agricultural development
- Fishery industries
- Mining and industrial development
- Communications
- Transportation
- Tourism
- Education, culture and youth including family planning and housing
- Manpower industry/transmigration
- law enforcement.

Agriculture received the first priority. National efforts will be directed towards increasing the productivity of farmers, fishermen, to meet self sufficiency in basic food production, expansion of agricultural exports, reduction in rural employment and conservation of agricultural resources. Irrigation programs part of the multi-purpose water resources development to increase agricultural productivity, facilitate the achievement of transmigration, conservation and flood control.

So the funds should finance efforts to rehabilitate existing irrigation networks, and construct new irrigation systems. The result should be to increase the nation's capacity to import through rising exports earning from this sector.

The government should also tighten control of forest exploitation and maximize returns on forestry resources. Fertilizer industries are also in this priority.

The conclusion by agriculture we mean

- cultivate the land
- irrigation systems
- industries of fertilizer
- industries of agricultural production
- fishing and fishery industry
- forestry and timber industries.

C. POPULATION (as manpower industry)

High rate of population increase and not being evenly spread out over the country are the factors which significantly influence the result of development in order for the people to increase the welfare. Highly increasing the population means more attention (work) needed to keep or to increase the certain level of welfare in consuming food, clothing, health, work, etc.

The uneven spread of the population between Java and other islands (regions) has been impeding the optimal using of national natural resources and labor, and also has been raising the problems concerning urbanization. According to the last census in 1971 the population of Indonesia is 119,383 million people. By this amount of population Indonesia is the fifth in the world. If we look at the census in 1930 the population was 60 million. In forty years the population has doubled. With rate (2.3%-2.4%)/year the population of Indonesia will be twice again in a short time, approximately 29 years. In Table (2-1) is shown the projection of the population withiin the five years planning. In 1978 by the

TABLE (2-1) PROJECTION OF POPULATION 1973-1978

| Year | Population in millions | Population Growth percentage |
|---|---|---|
| 1973 | 126.1 | 2.4% |
| 1974 | 129.1 | 2.3 |
| 1975 | 132.1 | 2.3 |
| 1976 | 135.2 | 2.3 |
| 1977 | 138.3 | 2.3 |
| 1978 | 141.6 | 2.3 |

Source: Rencana Pembaneunan Lima Tahun Kedua 1974/75 - 1978/79, I-IIA, Republik Indonesia.

end of the current FYDP the population will be 141.6 million people. This result is from the 1971 census; by assumptions the birth rate and death rate are not significantly changed.

D. SPREADING OF THE POPULATION

The population amount is not the main problem for Indonesia comparing the area and potential resources for development. The problem is that the population is not equally spread over the area and the high rate of birth. In 1971 the density of Java was about $565/km^2$* whereas the density of all Indonesia was just $58/km^2$*, more than 63% of the population lives in Java, which only 7% of the whole area of the Republic of Indonesia. Look at Table (2-2); the density in Java increased from $594/km^2$ in 1973 to $660/km^2$ in 1978, whereas in regions (not Java) the density increased from $24/km^2$ to $28/km^2$ within the same period. So, clearly manpower industry will help the transmigration department, and we include in manpower industry everything contributing to this project such as training and education.

The development and utilization of manpower resources will contribute to the increase of production, and to a better distribution of national income.

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*Rencana Pembangunan Limatahun Kedua 1974/75-1978/79, I-IIA, Republik Indonesia.

TABLE (2-2) POPULATION DENSITY IN JAVA AND OTHER REGIONS IN INDONESIA, 1973 AND 1978

| | Area in thousand square kilometers | Population 1973 (in millions) | Population 1978 (in millions) | Density 1973 per square kilometer | Density 1978 per square kilometer |
|---|---|---|---|---|---|
| Java | 135 | 80 | 89 | 594 | 660 |
| Other Regions | 1,892 | 46 | 53 | 24 | 28 |
| All over Indonesia | 2,027 | 126 | 142 | 62 | 70 |

Source: Rencana Pembangunan Lima Tahun Kedua 1974/75 - 1978/79, I-IIA, Republik Indonesia.

From Table (2-3) we can see the tendency of the population to be younger. More than 70% growth within this period is between age 10 and age 30; more than 63% of this workable people lives in Java. Probably the proportion is not linear because the welfare is not distributed equally.

## E. COMMUNICATIONS

Spreading out over the large area and surrounded by water, Indonesia realizes very well the immense problem of communications she faces. Developmental ideas could not possibly be implemented without the support of an efficient system of communications.

The smoothness of administrative operation in a unitary state consisting of many different parts, like Indonesia also very much depends on communication services, especially during this period of national development which not only activates the big cities but the remote villages and islands as well. Communications has also a principal meaning in the circulation, distribution and accumulation of goods and in the modernization of all aspects of the economy. Ideally, a nationwide communication system could establish the feeling of close unity among all the people throughout Indonesia, thereby strengthening the ties of nationhood.

As a member of the modern world, Indonesia should also be linked to the international communication network, not only for its own national interest but also for the more universal aim of peace and world prosperity.

TABLE 2-3 PROJECTION OF POPULATION GROWTH 1973-1978

| Age | Population in millions 1973 | 1978 | Percentage of Growth 1973-1978 | |
|---|---|---|---|---|
| 0-4 | 21.5 | 23.3 | 8.4% | |
| 5-9 | 18.6 | 20.0 | 7.5 | |
| 10-14 | 15.9 | 18.2 | 14.5 | |
| 15-19 | 12.3 | 15.5 | 26.0 | |
| 20-24 | 9.8 | 11.9 | 21.4 | 72.5 |
| 25-29 | 8.5 | 9.4 | 10.6 | |
| 30+ | 39.5 | 43.3 | 9.6 | |
| TOTAL | 126.1 | 141.6 | 12.3% | |

Source: Rencana Pembangunan Lima Tahun Kedua 1974/75 - 1978/79, I-IIA, Republik Indonesia.

TABLE 2-4 MANPOWER GROWTH VERSUS AGE 1973-1978

| Age | Manpower 1973 (in 1000 people) | Manpower 1978 (in 1000 people) | Growth Percentage 1973 - 1978 (%) |
|---|---|---|---|
| 10-14 | 2,598 | 2,979 | 14.7 |
| 15-19 | 4,789 | 6,034 | 26.0 |
| 20-24 | 5,212 | 6.473 | 24.2 |
| 25 or more | 29,818 | 32,640 | 9.5 |
| TOTAL | 42,417 | 48,126 | |

Source: Rencana Pembangunan Lima Tahun Kedua 1974/75-1978/79, I-IIA, Republik Indonesia.

TABLE 2-5 PROJECTION OF MANPOWER 1973-1978

| Year | Manpower (in 1000 people) | Manpower Growth (in 1000 people) | Percentage of Growth |
|---|---|---|---|
| 1973 | 42,417 | - | - |
| 1974 | 43,477 | 1,060 | 2.50 |
| 1975 | 44,573 | 1,096 | 2.52 |
| 1976 | 45,714 | 1,141 | 2.56 |
| 1977 | 46,898 | 1,184 | 2.59 |
| 1978 | 48,126 | 1,228 | 2.62 |

Source: Rencana Pembangunan Lima Tahun Kedua 1974/75-1978/79, I-IIA, Republik Indonesia.

By communication we mean:

- land transportation
- sea transportation
- air transportation
- postal service, Aero, Radio and T.V. Network
- electronic radio telecommunication.

The communication sector therefore must be planned to fulfill as far as possible the demands of community for communications and transportation facilities.

The several elements of land, sea and air transportation, of postal and telecommunication are to be developed harmoniously a synchronized, coordinated and integrated system so that they will be usually supporting each other. Past practice has exposed the bad effects, when the elements of communication were developed without coordination. Each one considered itself the most important. Consequently, unhealthy competition among the transportation elements existed, for example between airplanes and railways and ships and buses. Practically, communication and transportation could not cope with the normal demand.

In regions with underdeveloped road networks, rivers and canal transportation fulfill the vital role of economic, social and public traffic. In Kalimantan (Borneo), Sumatra, West Irian, some large rivers function as main transportation arteries including interconnecting canals.

Being a country consisting of thousands of big and small islands Indonesia is paying fullest attention to her sea transportation. Inter island transportation is built around

regular lines service system connecting the several trade centers throughout the nation. The national pattern has a functional link with international shipping routes, while the regional lines connect smaller harbors with trade centers, thus completing a trunk and feeder system. The regular lines system is served by both public and private companies in an efficiently coordinated joint operation.

The harbor is an important economic infrastructure supporting shipping, trade and industrial development. Port handling facilities should therefore be developed to assure smooth and quick dispatch of the liners, and also efficiency in port management will also imply the flow of goods.

Road transportation has a direct impact on the movement of goods and passengers and on the economy in general. Inter-provincial roads for motorized transport are found in Java, Sumatra and Bali and between certain cities outside these islands, while most of the outer islands or regions are still without connecting feeder roads. The government policy on road transportation should emphasize the development of facilities for more efficient, orderly and safe motor vehicle traffic. Increasing the number of vehicles is left to private companies. With more roads rehabilitated and new ones under construction, a better planned and continuous regulation for and control of the use of roads could be introduced. The main purpose is to prevent destruction of the roads. With the expansion of inter-regional trade and

increasing volume of timber exports the role of river transport has become more and more important. Air transportation requirements have increased rapidly in recent years along with the growth of economic activity in general. To meet this requirement, expansion and modernization of the air transport sector have been primarily directed as the improvement of navigation facilities such as telecommunications, air navigation improvement, etc.

All in all by transportation we do not mean only the vehicle itself but also all the facilities and industries that have direct impact on the development of the transportation systems, like tire factories, traffic safety, docking facilities, runways, rails, etc.

## F. TOURISM

Indonesia possesses certain advantages in the form of good tourist potential, like many places of interest, both from the point of cultural expression and national beauty. The development of tourism industries involved the construction of hotels, parks, and recreation centers and cultural centers and is tightly connected with the development of transportation and home industries. Travel bureaus, tourist guidance or tourist information centers in all regions may be developed. So by creating the tourism industries will give also a significant impact to the economy as a whole.

Success in development of communications and transportation will give the significant effort in solving transmigration

problem in the way to spread out population or manpower.

In this part we have described how strongly some industries development is interrelated to each other and by giving the priority to these industries we will create the economic activities. All these facts lead us to choose the suggested model as a regional or interregional input output model.

## IV. METHOD: THE BASIC INPUT-OUTPUT THEORY

In this part of the paper we will review briefly the Leontief input-output model. The input-output model is essentially a system of simultaneous linear production functions describing an economy considered as a unit.

### A. THE LEONTIEF CLOSED MODEL

Consider an exhaustive partition of an economy into n producing sectors of industrial development.

Let:

$x_i$ be the total gross output of the $i^{th}$ sector where $i = 1,2,...,n$

$x_{ij}$ be the input of $i^{th}$ product used by sector j to produce $x_j$

$x_{ij}$ describe the interrelation between sector i and sector j,
where: $i = 1,2,...,n$
$j = 1,2,...,n$

$y_i$ be the output of the sector i available for outside consumption or final demand

Then, the balance equation for commodity i can be described as:

$$x_i = \sum_{j=1}^{n} x_{ij} + y_i \qquad (3\text{-}1)$$

and $i=1,2,...,n$

This equation can be represented in table form that is called the transaction table:

TABLE (3-1) TRANSACTION TABLE

| Producing Sectors | Purchasing Sectors (Intermediate) | Final Demand | Gross Output |
|---|---|---|---|
| 1 | $x_{11}, x_{12}, \cdots\cdots, x_{1n}$ | $y_1$ | $x_1$ |
| 2 | $x_{21}, x_{22}, \cdots\cdots, x_{2n}$ | $y_2$ | $x_2$ |
| $\vdots$ | $\vdots \qquad \vdots$ | $\vdots$ | $\vdots$ |
| n | $x_{n1}, x_{n2}, \cdots\cdots, x_{nn}$ | $y_n$ | $x_n$ |

This table shows how the output of each producing sector is distributed among other producing sectors and sectors of the economy. At the same time it shows the inputs to each sector from other sectors. Leontief made the basic assumptions that:

1. The inputs to each sector are unique function of the level of output of that sector.
2. No joint products, no process produces more than one product.
3. No substitution among inputs is possible in the production of any goods or services.

## B. DIRECT PURCHASES AND TECHNICAL COEFFICIENT

Technical coefficients or table of inputs can be developed from an input-output table. They are calculated for processing sector industries only, and may be expressed in terms of money or physical terms. In this paper we use monetary terms. Based on the Leontief basic assumptions, we can see that:

- to produce one unit $x_j$, we need a certain amount of $x_{ij}$, the relation between them can be written as a linear function.

$$x_{ij} = a_{ij}x_j \tag{3-2}$$

and

$$a_{ij} = \frac{x_{ij}}{x_j} \tag{3-3}$$

$$i=1,...,n$$
$$j=1,...,n$$

where:

$a_{ij}$ is a certain amount of input $x_{ij}$ needed to produce one unit of output $x_j$, which also called technical coefficient.

By substituting (3-2) into (3-1) we obtain what is called the total gross output.

$$x_i = \sum_{j=1}^{n} a_{ij}x_j + y_i \tag{3-4}$$

$$i=1,...,n$$

Now it is clear that:

$A \quad = (a_{ij})$ is the matrix of input

$x_j \quad$ = one column matrix of output

$y_i \quad$ = one row matrix of final demand

or:

$$A = (a_{ij}) \quad \begin{matrix} a_{11} & \cdots\cdots\cdots & a_{1n} \\ \cdot & \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \cdot \\ \cdot & \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \cdot \\ a_{n1} & \cdots\cdots\cdots & a_{nn} \end{matrix}$$

$$x_i = (x_1, x_2, \ldots, x_n)$$

$$y_i = (y_1, y_2, \ldots, y_n)$$

and the column matrix of output:

$$x_j = \begin{matrix} x_1 \\ \vdots \\ x_n \end{matrix}$$

Matrix $A = (a_{ij})$ is also called input coefficient matrix or direct purchases per dollar of output and described in table for in Table (3-2).

TABLE (3-2) DIRECT PURCHASING TABLE

| | | Industries Purchasing | | | | |
|---|---|---|---|---|---|---|
| | Industry # | 1 | 2 | 3 | 4 | 5 |
| Industries Producing | 1 | $a_{11}$ | $a_{12}$ | $a_{13}$ | $a_{14}$ | $a_{15}$ |
| | 2 | $a_{21}$ | $a_{22}$ | $a_{23}$ | $a_{24}$ | $a_{25}$ |
| | 3 | $a_{31}$ | $a_{32}$ | $a_{33}$ | $a_{34}$ | $a_{35}$ |
| | 4 | $a_{41}$ | $a_{42}$ | $a_{43}$ | $a_{44}$ | $a_{45}$ |
| | 5 | $a_{51}$ | $a_{52}$ | $a_{53}$ | $a_{54}$ | $a_{55}$ |

From this table we can see that each dollar's worth of the production in industry #1 will require direct purchases from other industries as follows.

Intra industry transaction is $a_{11}$ (cents)

Purchases from industry #2 is $a_{21}$

Purchases from industry #3 is $a_{31}$

Purchases from industry #4 is $a_{41}$

Purchases from industry #5 is $a_{51}$

Total direct purchases of industry #1 from all other industries is $a_{11} + a_{21} + a_{31} + a_{41} + a_{51}$. In general, the total purchases by industry #j from all other industries will be:

$$\text{Total direct purchases by industry } j = \sum_{i=1}^{n} a_{ij} \quad .$$

Assuming constant technical from year to year and if we want to increase the output of industry #1 by \$100, if we can say, then the direct inputs of industry #1 would be increased by the following amounts:

Input from industry #1 would be increased by $100\ a_{11}$
Input from industry #2 would be increased by $100\ a_{21}$
Input from industry #3 would be increased by $100\ a_{31}$
Input from industry #4 would be increased by $100\ a_{41}$
Input from industry #5 would be increased by $100\ a_{51}$

Or in general to increase the output of industry #j by \$100, then the direct inputs of industry #j would be increased by

$$100 \sum_{i=1}^{n} a_{ij}$$ – total increased in inputs to increase the output of industry #j by \$100

Equation (3-4) can be written as:

$$X = AX + Y$$

$$Y = X - AX$$

$$Y = X(I-A)$$

$$X = (I-A)^{-1}\ Y \qquad (3\text{-}5)$$

where:

A is technical coefficient matrix

Y - gross output vector

I - identity matrix

or:

$$I = \begin{vmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & \\ \vdots & & \ddots & \vdots \\ 0 & & \cdots & 1 \end{vmatrix}$$

Given the final demand Y we can meet the gross output vectors X by readjustment of the matrix A for each industry. X is the output vector needed to meet as a target of development program. By forecasting the final demand (Y) for a certain period of time, say planning period of FYDP, we always can meet the output vector X by readjustment of the coefficient of input sectors on the entries of the input coefficient matrix.

Since the only inputs to the system are also the outputs it cannot produce and operate unless:

$$X \geq AX$$

or: $$(I-A)X \geq 0$$

This can be understood that the production of any one unit of good must not require directly more than one unit of itself. The Hawkins-Simon condition expressed in matrix form is as follows:

An input output system is viable if the $i^{th}$ principal minor of the matrix (A-I) has for sign $sgn(-1)^i$ for $i=1,2,\ldots,n$.

Consider a 2x2 input coefficient matrix:

$$A = \begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix}$$

The Hawkins-Simon conditions are:*

$$1 - a_{11} > 0 \qquad 1 - a_{22} > 0$$

$$\text{Det} \begin{vmatrix} 1 - a_{11} & -a_{12} \\ -a_{21} & 1 - a_{22} \end{vmatrix} > 0$$

In order for the technology matrix to have the inverse matrix $(I-A)^{-1}$, the determinant must be greater than zero.

An approximation of inverse $(I-A)^{-1}$ can be computed:

$$(I-A)^{-1} = I + A^2 + A^3 + \ldots$$

Direct and indirect purchases table is a table which represents direct and indirect purchases by purchasing industries from producing industries as a result of increasing in final demand.

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*James M. Henderson and Richard E. Quandt, Microeconomic Theory, A Mathematical Approach, p. 371.

By inserting a new final demand vector to this form we can get the new transaction table:

$$\sum_{j=1}^{n} y_{ij} b_{ij} = x_i^N$$

and

$$a_{ij} x_i^N = T^N$$

where: $x_i^N$ = new total gross output vector

$T^N$ = new transaction table.

The new equation for this new total gross output can be described by:

$$x_i^N = \sum_{j=1}^{n} a_{ij}(x_j^N) + y_i^N \quad , \quad i=1,\ldots,n$$

where: $a_{ij}$ = technical coefficients

$y_{ij}$ = new final demands

C. DIRECT AND INDIRECT PURCHASES TABLE

We have shown the technical coefficients or the table of input coefficients, the entries of which represent the direct purchases from industries at the top of the table needed to increase their outputs by one dollar. Matrix $(I-A)^{-1}$ is called the Leontief inverse matrix and each entry represents the direct and indirect requirements of

sector i per unit of final demand for the output of industry or sector j.

Let us denote $(I-A)^{-1} = B$, then: $B = (b_{ij})$ or:

$$B = \begin{vmatrix} b_{11} & \cdots & b_{1n} \\ \vdots & & \vdots \\ b_{n1} & \cdots & b_{nn} \end{vmatrix} \tag{3-6}$$

and we may write equation (3-5) as:

$$X = BY \tag{3-7}$$

and then:

$$x_i = b_{i1}y_1 + b_{i2}y_2 + \ldots + b_{ii}y_i + b_{ij}y_j + \ldots + b_{in}y_n \tag{3-8}$$

Another way to find direct and indirect purchases by using approximation of the inverse $(I-A)^{-1}$ as we have shown above as

$$(I-A)^{-1} = I + A + A^2 + A^3 + \ldots$$

Because it is the direct purchasing matrix, the indirect purchasing matrix can be described by:

$$[(I-A)^{-1} - A]$$

$$[B] - [A]$$

or

$$\left|\begin{array}{ccc} (b_{11}-a_{11}) & \cdots\cdots & (b_{1n}-a_{1n}) \\ \vdots & & \vdots \\ & (b_{ij}-a_{ij}) & \\ \vdots & & \vdots \\ (b_{n1}-a_{n1}) & \cdots\cdots & (b_{nn}-a_{nn}) \end{array}\right| \qquad (3\text{-}7)$$

The industries in processing sector have large inter-industry transactions means they have strong interdependence.

The analyst can choose industry that its the final demand is needed to be increased in order to create more activities in the processing sector, for example the output of agricultural industry depends upon the demand for processed food, tobacco, textiles, manpower, etc.

Let: [B] - [A] = [C], then we have the direct and indirect purchasing table:

TABLE (3-3) DIRECT AND INDIRECT PURCHASING

Industries Purchasing

| Industries # | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Industries Producing | 1 | $c_{11}$ | $c_{12}$ | $c_{13}$ | $c_{14}$ | $c_{15}$ |
| | 2 | $c_{21}$ | $c_{22}$ | $c_{23}$ | $c_{24}$ | $c_{25}$ |
| | 3 | $c_{31}$ | $c_{32}$ | $c_{33}$ | $c_{34}$ | $c_{35}$ |
| | 4 | $c_{41}$ | $c_{42}$ | $c_{43}$ | $c_{44}$ | $c_{45}$ |
| | 5 | $c_{51}$ | $c_{52}$ | $c_{53}$ | $c_{54}$ | $c_{55}$ |

APPENDIX

In order for the technology matrix to have the inverse matrix $(I-A)^{-1}$, the determinant must be greater than zero. An approximation of the inverse $(I-A)^{-1}$ can be computed.

$$(I-A)^{-1} = I + A + A^2 + A^3 + \ldots$$

Consider the matrix A:

$$A = \begin{vmatrix} .2 & .2 & .2 \\ .1 & .2 & .1 \\ .2 & 0 & .1 \end{vmatrix}$$

The powers of A are:

$$A^2 = \begin{vmatrix} .10 & .08 & .08 \\ .06 & .06 & .05 \\ .06 & .04 & .05 \end{vmatrix}$$

$$A^3 = \begin{vmatrix} .044 & .036 & .036 \\ .028 & .024 & .023 \\ .026 & .020 & .021 \end{vmatrix}$$

$$A^4 = \begin{vmatrix} .0196 & .0160 & .0160 \\ .0126 & .0104 & .0103 \\ .0114 & .0092 & .0093 \end{vmatrix}$$

$$A^5 = \begin{vmatrix} .00872 & .00712 & .00712 \\ .00562 & .00460 & .00459 \\ .00506 & .00412 & .00413 \end{vmatrix}$$

$(I-A)^{-1}$ approximated to the fifth power yields

$$(I-A)^{-1} = I + A + A^2 + A^3 + A^4 + A^5$$

$$= \begin{vmatrix} 1.37232 & .33912 & .33912 \\ .20622 & 1.29900 & .18750 \\ .30246 & .07332 & 1.18443 \end{vmatrix}$$

The actual inverse is:

$$\begin{vmatrix} 1.37931 & .34482 & .34482 \\ .21073 & 1.30268 & .18157 \\ .306513 & .076628 & 1.18773 \end{vmatrix}$$

## D. LEONTIEF OPEN MODEL

We can obtain the open model from the closed model by introducing the primary input sector. A primary input is not an output of any production process of the system; it can be identified with labor inputs or any scarce to the analysis of the model.

The system is now divided into two parts:

- The primary sectors which do not contain any producing industry.
- The secondary sectors that contain all the producing industries in the system.

Let $z_k$ be the total amount of the $k^{th}$ primary input k available and $z_{kj}$ be the amount of primary input k used by the $j^{th}$ industry.

Then:

$$\sum_{j=1}^{n} z_{kj} \leq z_k \qquad k = 1,2,\ldots,n$$

Define

$$b_{kj} = \frac{z_{kj}}{x_j}$$

as the amount of primary input k required per unit output j.

Then:

$$\sum_{j=1}^{n} b_{kj}x_j \leq z_k \qquad k = 1,2,\ldots,n$$

If the total quantity of primary input k is limited to a level $z_k^o$, then only a certain proportion of the final demand can be attained.

There is no fixed rule for including (excluding) any specific economic activity in the final demand (or payments) sectors. For some purposes it might be desirable to "close" the system with respect to one or more activities in the final demand (payments) sector. Household, for example, can be shifted into the processing sectors and the same is true of any other activity in final demand. Similarly some activities normally included in the processing sectors can be shifted to final demand. The decision of "how open" or "how closed" an input-output table is to be depends largely upon the purpose for which it is to be used.

## E. SIMPLIFIED INPUT-OUTPUT TRANSACTION TABLE

Table (3-4) represents a simplified input-output transaction table. This table can be the standard layout for the regional model. If we look at row i, the table shows the sales of industry to all other (intermediate demand) and to consumption, private investment, government spending and exports (which are components of final demand); intermediate demand plus final demand measures total gross output or sales j of industry i.

Thus in n-sector model:

$$x_i = \sum_{j=1}^{n} x_{ij} + (C_i + I_i + G_i + E_i) \qquad (3\text{-}8)$$

TABLE 3-4 SIMPLIFIED INPUT-OUTPUT TRANSACTION TABLE

| | | | INDUSTRY PURCHASING | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Output / Input | | | PROCESSING SECTOR | | | FINAL DEMAND | | | EXPORT | Total Gross Output |
| | | | INDUSTRY 1 ······ | j ········ | n | House-hold | Private Invest | Govern-ment | | |
| INDUSTRY PRODUCING | PROCESSING SECTOR | INDUSTRY 1 | $x_{11}$ | | $x_{1n}$ | $C_1$ | $I_1$ | $G_1$ | $E_1$ | $x_1$ |
| | | i | | $x_{ij}$ | | $C_i$ | $I_i$ | $G_i$ | $E_i$ | $x_i$ |
| | | n | $x_{n1}$ | | $x_{nn}$ | $c_n$ | $I_n$ | $G_n$ | $E_n$ | $x_n$ |
| | PAYMENT SECTOR | LABOR | $L_1$ | $L_j$ | $L_n$ | $L_C$ | $L_I$ | $L_G$ | $L_E$ | L |
| | | OTHER VALUE ADDED | $V_1$ | $V_j$ | $V_n$ | $V_C$ | $V_I$ | $V_G$ | $V_E$ | V |
| | | IMPORT | $M_1$ | $M_j$ | $M_n$ | $M_C$ | $M_I$ | $M_G$ | - | M |
| TOTAL GROSS OUTLAY | | | $x_1$ | $x_j$ | $x_n$ | C | I | G | E | X |

where:

$x_i$ - gross output

$\sum_{j=1}^{n} x_{ij}$ - intermediate demand

$C_i + I_i + G_i + E_i$ = final demand

Conversely, column j shows the purchases of industry j from all other industries (intermediate inputs), from primary inputs (labor, capital, etc.) which are value added entries taking the form of wages, profit, rent, interest, taxes and from imports. In the table value added is disaggregated into two payments only:

- payments to labor and to
- all other payments.

Similarly, we get:

$$x_j = \sum_{i=1}^{n} x_{ij} + L_j + V_j + M_j \qquad (3\text{-}9)$$

If we sum across totals row and down the totals column to yield the economy's total gross output:

$$X = \sum_{j=1}^{n} x_j + C + I + G + E \qquad (3\text{-}10)$$

since:

$$\sum_{i=1}^{n} x_i = \sum_{j=1}^{n} x_j \quad ,$$

so all intermediate flow can be cancelled out and we get

$$L + V + M = C + I + G + E$$

Transferring imports to the right hand side of the equation gives the traditional social accounting identity of gross regional income and gross regional product (expenditures), i.e.:

$$L + V = C + I + G + (E-M) \tag{3-12}$$

$L+V$ = gross regional income

$C+I+G+(E-M)$ = gross regional product

$E-M$ = net exports.

Frequently for analytical purposes, the final demand components are aggregated into a single vector Y.

Thus:

$$Y_i = C_i + I_i + G_i + E_i$$

and if we add to intermediate demand will be:

$$X_i = \sum_{j=1}^{n} X_{ij} + Y_i$$

which is already shown as a balance equation (3-1).

## F. TRANSACTION TABLE FOR THE OPEN MODEL

As we mentioned above, the "closed" model of Leontief can be "opened" by introducing the primary inputs, where the primary inputs are the commodity which are not the outputs of any production process of the system.

The transaction table consists of:

1. <u>The Processing Sector</u>

The upper left hand corner of the table is called the processing sector. This is the sector of input-output table which contains the industries producing goods and services. Among them we could find the agriculture, various manufacturing industries, transportation, communication and other utilities, wholesale and retail trade, the service industries as are isolated for separate treatment in the table.

2. <u>The Payment Sector</u>

On the left hand side of the table rows 7 to 11 are set off under the heading payments sector, this sector consists of:

a. Gross inventory depletion, that means the using up of previously accumulated stocks of raw materials, intermediate goods, or finished products.

b. Imports, the value of imports purchased by each industry and sector from abroad.

c. The payment to government; can be in the form of taxes, represents purchases of government services such as police and fire protection, maintenance of the armed

TABLE 4-2 TRANSACTION TABLE FOR OPEN MODEL

| | OUTPUTS / INPUTS | INDUSTRY PURCHASING: PROCESSING SECTORS (1) | (2) | (3) | (4) | (5) | (6) | FINAL DEMAND (7) | (8) | (9) | (10) | (11) | (12) | (13) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INDUSTRY PRODUCING: PROCESSING SECTORS | (1) Industry A | $x_{11}$ | $x_{12}$ | $x_{13}$ | $x_{14}$ | $x_{15}$ | $\sum_{j=1}^{5} x_{ij}$ | $y_{11}$ | $y_{12}$ | $y_{13}$ | $y_{14}$ | $y_{15}$ | $y_i = \sum_{j=1}^{5} y_{ij}$ | $x_1$ |
| | (2) Industry B | $x_{21}$ | | | | | | $y_{21}$ | | | | | | $x_2$ |
| | (3) Industry C | | | | | | | $y_{31}$ | | | | | | $x_3$ |
| | (4) Industry D | | | | | | | $y_{41}$ | | | | | | $x_4$ |
| | (5) Industry E | $x_{51}$ | | | | | | $y_{51}$ | $y_{52}$ | $y_{53}$ | $y_{54}$ | $y_{55}$ | | $x_5$ |
| | (6) Total Produced Inputs | $\sum_{i=1}^{5} x_{i1}$ | | | | | $\sum_{i,j=1}^{2\ 5} x_{ij}$ | $y_j = \sum_{j=1}^{m} y_{ij}$ | | | | | $y = \sum_{i=1}^{m} \sum_{j=1}^{n} y_{ij}$ | $\sum_{i=1}^{5} x_i$ |
| PAYMENTS SECTORS | (7) Gross Inventory Depletion (-) | $v_{11}$ | $v_{12}$ | | | | $v_{16}$ | $v_{17}$ | | | | $v_{1\,11}$ | $v_1 = \Sigma v_{1j}$ | De |
| | (8) Imports | $v_{21}$ | | | | | | | | | | | $v_2 = \Sigma v_{2j}$ | M |
| | (9) Payment to Government | $v_{31}$ | | | | | | | | | | | $v_3 = \Sigma v_{3j}$ | T |
| | (10) Depreciation Allowances | $v_{41}$ | | | | | | | | | | | $v_4 = \Sigma v_{4j}$ | A |
| | (11) Households | $v_{51}$ | | | | | $v_{66}$ | $v_{67}$ | | | $v_{69}$ | $v_{11\,11}$ | $v_5 = \Sigma v_{5j}$ | H |
| | (12) Total Gross Outlays | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $\sum_{i=1}^{5} x_i$ | S | E | G | I | C | $V = \sum_{i=1}^{m} \sum_{j=1}^{n} v_{ij}$ | X |

forces, and similar services which most of us take for granted.

d. Depreciation allowances; represent the numbers approximating the cost of plant and equipment used up in the production of the goods and services represented in this table.

e. Households; represent the wages, salaries, dividends, interest, similar payments made to the households by each of the industries and other sectors listed across the top of the table.

3. <u>The Final Demand Sector</u>

a. Gross inventory accumulation. This column shows the amount of addition to inventories held by each of the industries and sectors along the left hand side of the table. During any given time period, some of the goods produced do not get into the hand of their final consumers. They must keep a stock of goods on their warehouses. This column shows the amount of inventories accumulated during the period covered by the table regardless of where those inventories are held, whether at the factory, in a warehouse, or retail establishments.

b. Exports, this column shows the value of exports from each of the processing industries and other sectors during the period covered by the table.

c. Government purchases; purchases made by all levels of government are given in this column. The entry where government column and government intersect indicates that there are some intra-governmental transactions.

d. Gross private capital formation, shows the amount of sales from each industry or sector along the left side of the table to buyers who their purchases for private capital formation.

e. Column: households represents purchases of finished goods and services by their ultimate consumers from the industries and other sectors along the left hand side of the table.

4. Total Gross Output and Total Gross Outlay

The final row and column of the table represents the total value of output of each of the industries on the left side of the table and the total value of inputs to each of those industries.

The total of all rows in the payment sector must equal the total of all columns in the final demand sector, for the same reason that the Gross National Product computed from the product side must equal Gross National Product computed from factor payments.

# V. INTERREGIONAL INPUT-OUTPUT MODEL

## A. INTERREGIONAL INPUT-OUTPUT AS A PLANNING TOOL

The purpose of Interregional input-output model is to analyze the inter-relations among trade and production in two or more regions. In this paper we divide Indonesia into four regions likewise there are four defense regions

The interregional input-outputmodel in fact is the composition of four basic input-output models of each region. The row import and column export are changed by the inter-regional trade row and column. The household sector is placed in the processing sector.

As we mentioned above this model can be used by an administrator to keep all regions in balance, or we can reach the income just about in the same level in all regions as desired. By this way the central goverment should be able to give the guidance to the regions in developing their own industries. The central government can choose what industry should be developed, for example in regions which have less density of population the central goverment can choose to develop the more extensive labor industries in order to stimulate the transmigration of manpower from Java to other regions, as one of the goverment policies and give more spending in this sector.

The central goverment can also lead the regions to the situation of development competition among the regions and

will create the economic activities. The central government by looking to the model should be able to rank the regions in the sense of income and full-employment criteria and determine the injection policy to the regions. By all this, we mean the model as a planning tool for the central government as the theme of this paper.

B. THE IDEAL INTERREGIONAL MODEL

The full-scale interregional input-output model aims at treating z regions ($z \geq 2$) in equal detail. A complete interindustry matrix is specified for each region, and in addition interindustry flows in a set of interregional matrices, with one matrix for each pair of regions. Thus a complete four-region interregional model for Indonesia would contain a total of sixteen sub-matrices; four intra-regional matrices or the diagonal and twelve inter-regional matrices. This enables each economic activity to be identified by industrial group (1,...,i,j,...,n) and by location; i.e. by region (1,...,r,s,...,z). The aggregate interregional technical coefficient matrix has $(nz)^2$ separate cells. Each region has nxn-matrix, representing its own industrial structure and (z-1) other nxn-matrices illustrating the interindustry interregional relationships. Abstracting from industry and product mix and from regional differences in production techniques, any sector i in one region could be identical in structure and composition to industry i in any other region.

The distinctive feature of the "ideal" interregional model is that it treats these apparently identical sectors as distinguishably separate industries. The very fact of their being produced in separate regions makes them different. In consequence, the interregional-interindustry coefficient is put on the same basis and is found by the same assumptions as the local interindustry coefficient; both are treated as the standard input coefficients of Leontief models. Thus any change in final demand directly calls for a proportional change in each of the inputs — not only each local industry input but also in each industry input from the other regions of the system.

## C. THE INTER-REGIONAL FLOW

The interregional model can be expressed by modifying the usual input-output equation;

Gross Output = input requirements + final demand

in the following way:

$$x_i^r = \sum_{j=1}^{n} \sum_{s=1}^{z} x_{ij}^{rs} + \sum_{j=1}^{z} y_i^{rs} \qquad (4\text{-}1)$$

where:

$x_i$ = gross output of industry i in region r

TABLE 4-3 SKELETON TABLE INTER-REGIONAL INPUT-OUTPUT MODEL

| FROM \ TO | | | REGION R | REGION S | REGION T | REGION U |
|---|---|---|---|---|---|---|
| | | | INDUSTRY # 1 j n | INDUSTRY # 1 j n | INDUSTRY # 1 j n | INDUSTRY # 1 j n |
| REGION R | INDUSTRY # | 1 i n | $x_{ij}^{rr}$ | $x_{ij}^{rs}$ | $x_{ij}^{rt}$ | $x_{ij}^{ru}$ |
| REGION S | INDUSTRY # | 1 i n | $x_{ij}^{sr}$ | $x_{ij}^{ss}$ | $x_{ij}^{st}$ | $x_{ij}^{su}$ |
| REGION T | INDUSTRY # | 1 i n | $x_{ij}^{tr}$ | $x_{ij}^{ts}$ | $x_{ij}^{tt}$ | $x_{ij}^{tu}$ |
| REGION U | INDUSTRY # | 1 i n | $x_{ij}^{ur}$ | $x_{ij}^{us}$ | $x_{ij}^{ut}$ | $x_{ij}^{uu}$ |

$$\sum_{j=1}^{n} \sum_{s=1}^{z} x_{ij}^{rs}$$ = all intermediate output of industry i, used by all industries in all regions, including industry i itself.

$$\sum_{j=1}^{z} y_{i}^{rs}$$ = all the final demand of industry i in region r used by all regions.

There will be nz equations of this type. The output of each industry in each region is equal to its sales to all industries and final demand sectors in all regions, including its own.

The individual inter-regional interindustry trade coefficients are divided from the observed output $x_j^s$ , i.e.:

$$R_{ij}^{rs} = \frac{x_{ij}^{rs}}{x_j^s} \tag{4-2}$$

where:

$x_{ij}^{rs}$ = the flow from industry i in region r to industry j in region s.

$x_j^s$ = total gross output of industry j in region s.

$R_{ij}^{rs}$ = the spatial input coefficient indicating the amount of output i from region r needed per unit of output by industry j in region s.

Substituting (4-2) into (4-1), we obtain:

$$x_i^r = \sum_{j=1}^{n} \sum_{s=1}^{z} R_{ij}^{rs} + \sum_{j=1}^{z} y_i^{rs} \tag{4-3}$$

From Table (4-3) it can also be seen clearly that:

$$x_i^r = x_i^{rr} + x_i^{rs} + x_i^{rt} + x_i^{ru} \qquad (4-4)$$

In more general terms, for a z-region model

$$x_i^r = x_i^{rr} + \sum_{i=1}^{z-1} x_i^{rs} \qquad (4-5)$$

Furthermore, in a closed interregional system total interregional exports must equal to total interregional inports for each commodity, this is obvious because an export for one region becomes an import for another one.

$$\sum_{r}^{z} \sum_{l}^{z} x_i^{rs} = \sum_{l}^{z} \sum_{r}^{z} x_i^{sr} \qquad (4-6)$$

As mentioned above we use the term interregional trade among the regions instead of interregional export and import.

This model originally was formulated by Isard and may be considered as an ideal model [R.F. Riefler, p. 25]. The coefficient $R_{ij}^{rs}$ defined by (4-2) is assumed to be stable over time when projecting future output and multipliers. The significance of this assumption can be illustrated if we let $a_{ij}^s$ represent the regional technical coefficient expressing the amount of input of industry j in region s, from output of industry i, wherever located, to produce one unit of output industry j, then:

$$R_{ij}^{rs} = t_{ij}^{rs} a_{ij}^{s} \tag{4-7}$$

where:

$t_{ij}^{rs}$ = the proportion of the total amount of output of industry i in region r, needed for industry j in region s, supplied by industry in region r.

Coefficient $t_{ij}^{rs}$ shows how much region s depends on region r in terms of amount of output of industry i, compared to all other industries in the region. We can rank the dependence of each region to another by industries.

It is clear now that coefficient $R_{ij}^{rs}$ is the key to the empirical application of the interregional input output model. It shows how much each industry depends on the output of other from different regions.

In order to derive these we have to measure interregional trade flows by region of origin and destination and by industry of source and purchasing sector.

No developing country as yet possesses interregional trade statistics capable of this degree of disaggregation. Even for the United States consistent data from which these input coefficients ($R_{ij}^{rs}$) can be directly computed are not available.*

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*Harry W. Richardson: Input-Output and Regional Economics, John Wiley & Sons, 1972.

## D. SIMPLIFICATION OF IDEAL INTERREGIONAL MODEL

There have been four distinct approaches to an empirically applicable simplification of the ideal interregional model to estimate the interregional coefficients of flow.

1. By Moses

$$R_{ij}^{rs} = \frac{(a_{ij}^{s} x_{j}^{s})\ L_{i}^{r}}{x_{j}^{s}} \tag{4-8}$$

where:

$a_{ij}^{s}$ = regional technical coefficient (region s)

$x_{j}^{s}$ = the total gross output of industry j in region s

$$L_{i}^{r} = \frac{x_{i}^{r}}{x_{i}} \tag{4-8a}$$

where

$x_{i}$ = output of industry i in all regions or national output of industry i

$x_{i}^{r}$ = output of industry i in region r.

The advantage of this approach is that it requires no data on actual trade flows ($x_{ij}^{rs}$ or $t_{ij}^{rs}$).

A second approximation to the ideal interregional input-output model has been formulated by Leontief with collaboration of Strout.

2. By Leontief and Strout

$$R_{ij}^{rs} = \frac{(x_i^r \cdot U_i^s / x_i)\ Q_i^{rs}}{x_j^s \quad a_{ij}^s} \qquad (4\text{-}9)$$

where:

$x_i^r$ = the output of industry i in region r.

$x_i$ = the national output of industry i

$x_j^s$ = the output of industry j in region s

$U_i^s$ = the total internal output (production plus imports minus exports) of industry i in region s

$a_{ij}^s$ = technical coefficient of region s

$Q_i^{rs}$ = location coefficient (constant) locational preference coefficient.

$Q_i^{rs}$ can be estimated by

$$Q_i^{rs} = (E_i^r + K_i^s)\ d_i^{rs}\ V_i \qquad (4\text{-}9a)$$

where:

$E_i^r$ = parameter characterizing the relative position of region r versus all other regions as supplier of industry i

$K_i^s$ = represents a parameter characterizing the position of region s versus all other regions as a measure of industry i.

$d_i^{rs}$ = the inverse of the per unit transport cost from region r to region s.

$V_i$ = a dummy variable; equal to zero if no shipments are expected; otherwise equal to one.

Like the first model this model estimates interregional coefficients without actual data on interregional flows. This model, however, does not require the a prior identification of local and national industries and it does allow the cross-hauling of commodities between regions.

3. <u>By Moses and Chenery</u>

The interregional flows are estimated by:

$$R_{ij}^{rs} = a_{ij}^{s}\ t_{i}^{rs} \qquad (4\text{-}10)$$

where:

$a_{ij}^{s}$ = technical coefficient of region s

$$t_{i}^{rs} = \frac{z_{i}^{rs}}{z_{i}^{s}} \qquad (4\text{-}10a)$$

where:

$z_{i}^{rs}$ = the amount of good i purchased by all region s industries, and final demand, from region r.

$$\left( = \sum_{j=1}^{n} x_{ij}^{rs} + y_{i}^{rs} \right)$$

$z_{i}^{s}$ = total purchases of good i by all industries and final demand sectors in region s from all regions

$$\left( = \sum_{r=1}^{n} \sum_{j=1}^{m} x_{ij}^{rs} + \sum_{r=1}^{n} y_{i}^{rs} \right)$$

so:

$$t_{i}^{rs} = \frac{\sum_{j=1}^{n} x_{ij}^{rs} + y_{i}^{rs}}{\sum_{r=1}^{n} \sum_{j=1}^{m} x_{ij}^{rs} + \sum_{r=1}^{n} y_{i}^{rs}} \qquad (4\text{-}10b)$$

The advantages of this approach are basically its consistency with published statistics on interregional commodity flows and its ability to capture cross-hauling of commodities.

4. <u>By Riefler and Tiebout</u>

This approach estimates the interregional flow coefficients by:

$$R_{ij}^{rs} = t_i^{rs} (a_{ij}^{s} - a_{ij}^{ss}) \qquad (4\text{-}11)$$

where:

$a_{ij}^{s}$ = technical coefficients of region s

$a_{ij}^{ss}$ = the amount of output of industry i in region s purchased per unit of output j in region s.

$$t_i^{rs} = \frac{z_i^{rs}}{\sum\limits_{\substack{r=1 \\ r\neq s}}^{n} z_i^{rs}} \qquad (4\text{-}11a)$$

where $z_i^{rs}$ is defined in (4.10a).

One of these four approaches can be chosen to estimate the interregional flow coefficients, depending on the data available. Ranking these approaches in terms of data requirements would find the ideal model at the top of all followed by Riefler and Tiebout approach, Moses-Chenery approach, Leontief-Moses and Leontief-Strout approach.*

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*George G. Judge and Takashi Takayama; Studies in Economic Planning over Space and Time, North-Holland/American Elsevier, 1973.

# V. THE MULTIPLIER ANALYSIS

## A. THE MULTIPLIER EFFECTS

As it is mentioned above that one of the goals is to create the new job or to stimulate the economic acitivy in all regions. To meet the new increasingly final demand we need to increase the entries in the processing sectors of the transaction table. It means the new government spending, or new investment in the economic system.

From the theory of macroeconomics, an increase in net investment will cause a magnified increase in income and output and decrease in net investment will cause a magnified decrease in income and output. Investment spending thus has an amplifying effect on economic activity. The amount by which a change in investment is multiplied to produce a change in income and output is called the multiplier. The multiplier principle states that changes in investment bring about magnified changes in income as expressed by equation:

multiplier x change in investment = change in income.

The formula for the multiplier coefficient is thus:

$$\text{MULTIPLIER} = \frac{\text{CHANGE IN INCOME}}{\text{CHANGE IN INVESTMENT}}$$

$$= \frac{1}{\text{MPS}} = \frac{1}{1 - \text{MPC}}$$

where:

$$MPC + MPS = 1$$

MPC = marginal prospensity to consume

MPS = marginal prospensity to save.

From the formula we can see that the larger the MPC the larger the multiplier, for example, if MPC = .80, the multiplier is 5, and if MPC = .90, the multiplier is 10. From an economic point of view the relationship between multiplier and MPC is reasonable. The higher the MPC, the more people will spend of an incremental increase in income, hence the larger is the amount of income received by the people in the next round, etc. Input output multipliers are the important tool used in local and regional economic impact analysis.

There are some multipliers which need to be distinguished.

1. <u>Output Multiplier</u>

The output multiplier for industry i measures the sum of direct and indirect requirements from all sectors needed to deliver one dollar more of output of industry i to final demand. It serves as indicator of the degree of structural interdependence between each sector and the rest of the economy.

2. <u>Income Multiplier (Type I)</u>

This is expressed as the ratio of the direct plus indirect income change to the direct income change resulting from a unit increase in final demand for any given industry.

The direct income change for each sector is given by the household row's entry of the regional input-output table when expressed in input-coefficient form (i.e., direct coefficient table $a_{ij}$). The direct and indirect income change is obtained by multiplying each column entry in the standard inverse matrix by the supplying industry's corresponding household row coefficient from the direct coefficient table and summing all together. Thus the direct and indirect income change for sector j is given by:

$$\sum_{i=1}^{n} b_{ij}\, h_{R_i} \qquad (i=1,\ldots,n)$$

where:

$b_{ij}$ = direct and indirect change (from Leontief inverse matrix $B = (b_{ij})$)

$h_{R_i}$ = household row entry from the transaction table in coefficient form

$$h_{R_i} = \frac{x_{ij}}{x_j} \quad , \quad i \text{ is household sector.}$$

3. <u>Income Multiplier (Type II)</u>

This is the ratio of direct, indirect, and induced income change to the direct income change due to a unit increase in final demand. The difference with type II is the household becomes endogenous or (A*) .

A* is technical coefficient matrix with household row and column endogenous

$$A^* = (a_{ij}^*)$$

Leontief inverse matrix with household endogenous will be:

$$(1 - A^*)^{-1} = B^* = (b_{ij}^*)$$

If the household is $i^{th}$ industry the direct, indirect and induced income changes will be:

$$b_i^* = (b_{i1}^*, b_{i2}^*, \ldots, b_{in}^*)$$

and type II income multiplier $= \dfrac{b_{ij}^*}{h_{R_i}}$

where:

$$h_{R_i} = \frac{x_{ij}}{x_j}$$ , i is household industry as defined before.

B. COMPUTATIONAL PROCEDURE OF MULTIPLIER

To compute the multiplier we need first to "close" the basic transactions table with respect to household, then we have the table shown in Table 4-4. H is the household industry, $n^{th}$ sector. From this table we have shown how to compute the technical coefficient table or input coefficient matrix, described by $A^*$.

Matrix $A^* = (a_{ij}^*)$ we call direct input coefficient matrix with household endogenous. Then

$$a_{ij}^* = \frac{x_{ij}}{x_i}$$

TABLE (4-4) TRANSACTION TABLE WITH HOUSEHOLD ENDOGENOUS

| OUTPUT / INPUT | | PROCESSING SECTOR 1 2 | j | H | FINAL DEMAND | TOTAL GROSS OUTPUT |
|---|---|---|---|---|---|---|
| PROCESSING SECTOR | 1 | $x_{11}$ | | $x_{1n}$ | $y_1$ | $x_1$ |
| | 2 | | | | | |
| | | | $x_{ij}$ | | | |
| | H | $x_{n1}$ | | $x_{nn}$ | $y_n$ | $x_n$ |
| OTHER VALUE ADDED | | $v_1$ | | $v_n$ | $v_y$ | $x_v$ |
| TOTAL GROSS OUTLAY | | $x_1$ | | $x_n$ | $x_y$ | $x$ |

TABLE (4-5): DIRECT INPUT COEFFICIENT MATRIX WITH HOUSEHOLD ENDOGENOUS

| input \ output | Processing Sector 1 | 2 | ... | j | ... | H |
|---|---|---|---|---|---|---|
| 1 | $a^*_{11}$ | | | | | $a^*_{1n}$ |
| 2 | | | | | | |
| ⋮ | | | | | | |
| i | | | | $a^*_{ij}$ | | |
| ⋮ | | | | | | |
| H | $a^*_{n1}$ | | | | | $a^*_{nn}$ |

By subtracting from identity matrix we can obtain the Leontief inverse matrix with household endogenous, Table (4-6)

$$(I - A^*) = B^* = (b^*_{ij})$$

TABLE (4-6)

| | Processing Sector 1 | 2 | ... | j | ... | H |
|---|---|---|---|---|---|---|
| 1 | $b^*_{11}$ | | | | | $b^*_{1n}$ |
| 2 | | | | | | |
| ⋮ | | | | | | |
| i | | | | $b^*_{ij}$ | | |
| ⋮ | | | | | | |
| H | $b^*_{n1}$ | | | | | $b^*_{nn}$ |

Now to compute the multiplier type I we are using matrix (3-2), Direct Purchasing matrix. This table is household exogenous, the household is not in the processing sector, and matrix (4-6) is the standard Leontief inverse matrix also with household exogenous. The result is presented in Table (4-7). In computating income multiplier type II we use the matrix with household endogenous Table (4-6) and household coefficient using Table (4-5). The result is presented in Table (4-8).

## C. EMPLOYMENT MULTIPLIER

One of the government programs is to spread out the population over all regions. By choosing the right sector of industry to be built or to be expanded by giving some more spending or investment by central government in a particular region, we can give significantly effort to meet this program. As it is mentioned early in this paper that the more labor extensive industry should be chosen to build or to be expanded in the regions out of Java. This section will give the guidance in choosing such industry by showing how the effect in employment if we give some more spending or new investment in a particular region. The method we are going to describe is the Moore-Peterson method in their study in Utah.

The Moore-Peterson method for employment multipliers is based on employment-production functions, which are computed for each industry in the transaction table.

TABLE 4-7 COLUMN MULTIPLIER AND INCOME MULTIPLIER TYPE I

| OPEN MODEL | Industry 1 | Industry j | Industry n |
|---|---|---|---|
| Column multiplier | $\sum_{i=1}^{n} b_{i1}$ | $\sum_{i=1}^{n} b_{ij}$ | $\sum_{i=1}^{n} b_{in}$ |
| Household row coeff. | $h_1$ | $h_j$ | $h_n$ |
| Direct and Indirect income change | $b_{11} \cdot h_1 + b_{21} \cdot h_2$ | $\sum_{i=1}^{n} b_{ij} h_i$ | $\sum_{i=1}^{n} b_{in} \cdot h_n$ |
| Type I multiplier Income Multiplier | $\frac{b_{11} \cdot h_1 + b_{21} \cdot h_2}{h_1}$ | $\frac{\sum_{i=1}^{n} b_{ij} h_i}{h_i}$ | $\frac{\sum_{i=1}^{n} b_{in} \cdot h_n}{h_n}$ |

Note: Household row coefficient is computed by dividing the household entries with the total gross outlay in the same column from transaction table open model. In our case from Table 4-2 the household row coefficients are:

$$\left(\frac{v_{51}}{x_1}, \frac{v_{52}}{x_2}, \frac{v_{53}}{x_3}, \frac{v_{54}}{x_4}, \frac{v_{55}}{x_5}\right)$$

TABLE 4-8 INCOME MULTIPLIER TYPE II

| Closed model (Household Endogenous) | Industry 1 | Industry j | Industry n |
|---|---|---|---|
| Direct, Indirect and induced income changes | $b^*_{n1}$ | $b^*_{nj}$ | $b^*_{nn}$ |
| Income multiplier Type II | $\frac{b^*_{n1}}{h_1}$ | $\frac{b^*_{nj}}{h_j}$ | $\frac{b^*_{nn}}{h_n}$ |

$b^*_{nj}$ - entries of household row from matrix (4-6)

$h_1$ - same as in Table 4-7

A change in final demand results in two related and mutually interacting events:

(1) a change in production and a change in income directly,
(2) a further change in consumer expenditures via consumption function which in turn generates change in production, income, and so one for succesive rounds.

The employment-production function measures the relationship between total-employment (in man years) in each industry and the gross output of that industry expressed in millions of dollars.

The slope of each employment-production function which measures the rate of change of employment as output change, is used to measure the direct change in employment associated with a million dollar change in final demand. The number representing this slope of each employment production function is called the appropriate employment function.

In their study in Utah, Moore and Petersen assumed that both consumption and employment funtions are linear, that is they are simple equations which state that changes in employment are proportional to changes in output and consumer expenditure on each commodity is directly proportional to income.

By adopting this assumption we can describe the employment production function by:

$$E_i = E_{io} + e_i x_i$$

where:

$E_i$ = total employment (in man-years) in industry i,

$x_i$ = gross output of industry i in millions of dollars

$e_i$ = direct employment change per one million dollar demand change

$E_{io}$ = initial employment.

Direct and indirect effects of employment per one million dollars can be computed as follows:

The entries of the direct and indirect purchasing table (4-7) and (4-8) multiplied by the appropriate employment production function and summing each row,

For industry i: (from table (4-8)

$$(c_{i1} + c_{i2} + \ldots + c_{in}) \cdot e_j = \sum_{j=1}^{n} c_{ij}\, e_j$$

where

$$\sum_{j=1}^{n} c_{ij} e_j \quad = \quad \text{direct and indirect change of employment.}$$

The "simple" multiplier analogous to type I income multiplier is:

$$\frac{\sum_{j=1}^{n} c_{ij} e_j}{e_j} = \text{"simple" employment multiplier}$$

This figure shows, for each man-year of employment in the industry i, this amount of employment is generated in the region from the production adjustments.

To measure the direct, indirect and induced employment changes — similar to income multiplier type II — Moore and

Petersen used both, the employment-production functions and consumption function.

A consumption function is an equation which shows the proportion of an increase in income which is spent on consumption. A sectoral consumption function is one which shows how much of a given change in income will be spent in a particular sector. The logic behind the linking of consumption functions and employment functions is that of the "chain reaction" as the effect of additional spending or investment on the system (economic system).

Here, we describe one "round" of chain: change in final demand, leads to → direct and indirect change in output → change in employment (as a "simple" employment multiplier) → change in income again → change in consumer demand. So the direct, indirect and induced employment change is the expansion of the direct and indirect change, to the next round process in our economic system. Moore and Petersen in their study of an interindustry model in Utah traced this process through three rounds.

The total employment multiplier is the direct, indirect and induced employment change divided by direct employment change ($e_i$).

## VII. CLOSING REMARKS

In this paper we have shown how the input coefficients must be rearranged to meet the change in final demand. The final demand change in turn is a projected final demand over the one period time, time covered by transaction table for example is Fiscal Year Development Program, as a government goal based on population growth in Table (2-1). For this purpose Time Series Analysis is widely used. We restricted ourselves in this problem.

Further, in this paper we have shown how to compute the total gross output both for regions and nationally. How each industry depends on other industries in the region and from other regions also has been described.

Another very important feature is the multiplier impact, income and employment, or the effects of additional spending or investment on a particular industry in the region.

Further analysis can be carried out using the linear programming method to obtain the maximum relation between projections of production levels and use of resources on the one hand and the criteria for choice of investments on the other. The formal programming problem is to maximize (or minimize) a function of the activity levels subject to a set of linear constraints on these variables. In planning development, the function to be maximized is the national product. Employment, income distribution, the availability

of resources and labor and capital, domestic saving or foreign borrowing, can be considered as constraints.

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